

TECHNICAL MANUAL
No. 5-850-2
AIR FORCE MANUAL
No. 32-1046 }

HEADQUARTERS
DEPARTMENTS OF THE ARMY
AND AIR FORCE
WASHINGTON, DC, 16 October 1995

RAILROAD DESIGN AND REHABILITATION

		Paragraph	Page
CHAPTER	1. GENERAL INFORMATION		
	Purpose	1-1	1-1
	Scope	1-2	1-1
	References	1-3	1-1
	Organization and Use of the Manual	1-4	1-1
	Supplementary Material	1-5	1-1
	Using the AREA Manual for Railway Engineering	1-6	1-1
	Applicability of State and Commercial Railroad Standards	1-7	1-2
	Sources of Assistance	1-8	1-2
2.	DETERMINING TRAFFIC AND LOAD CARRYING REQUIREMENTS		
	Introduction	2-1	2-1
	Traffic Type	2-2	2-1
	Traffic Volume	2-3	2-1
	Wheel Loads	2-4	2-1
	Locomotive Tractive Effort	2-5	2-1
	Traffic and Terminals	2-6	2-2
	Sources for Traffic Information	2-7	2-2
3.	ESTABLISHING ROUTE PROFILE AND ALIGNMENT SPECIFICATIONS		
	Introduction	3-1	3-1
	Grades and Grade Resistance	3-2	3-1
	Route Profile and Transitions Between Grades	3-3	3-1
	Curvature, Curve Resistance, and Effective Grade	3-4	3-1
	Locomotive Tonnage Rating	3-5	3-3
	Trial Ruling Grade	3-6	3-3
4.	ROUTE SELECTION		
	Introduction	4-1	4-1
	Establishing Control Points and Potential Corridors	4-2	4-1
	Reconnaissance	4-3	4-1
	Initial Survey	4-4	4-2
	Trial Location	4-5	4-2
	Final Location	4-6	4-3
5.	REHABILITATION: TRACK, BRIDGES, AND TERMINALS		
	Definition and Application	5-1	5-1
	Installation Requirements and Facility Evaluation	5-2	5-1
	Condition Evaluation	5-3	5-1
	Structural Evaluation	5-4	5-2
	Operational Evaluation	5-5	5-2
	The Rehabilitation Plan	5-6	5-2
	Final Plans and Specifications	5-7	5-3
	Construction and On-Site Inspection	5-8	5-4
6.	STRUCTURAL DESIGN		
	Track Structure	6-1	6-1
	Track Design Methods	6-2	6-1
	AREA Design Procedure (Modified)	6-3	6-1
	Roadway	6-4	6-6
	Subgrade	6-5	6-6
	Frost Design Modifications	6-6	6-10
	Drainage	6-7	6-14
	Geotextiles	6-8	6-15
	Ballast	6-9	6-16
	Sub-Ballast	6-10	6-17
	Ties and Tie Spacing	6-11	6-18
	Rail	6-12	6-19
	Other Track Material	6-13	6-21

*This manual supersedes TM 5-850-2/AFM 88-7, Chap. 2, dated 1 July 1980

	Paragraph	Page
Turnouts and Crossovers	6-14	6-24
Road Crossings	6-15	6-28
Rail Crossings	6-16	6-36
Bridges	6-17	6-37
Miscellaneous Track Appliances	6-18	6-40
7. GEOMETRIC DESIGN		
Roadway Cross Section	7-1	7-1
Grades and Track Profile	7-2	7-1
Horizontal Curves	7-3	7-1
Turnouts	7-4	7-2
Track Connections and Ladder Tracks	7-5	7-4
Clearances	7-6	7-4
Road Crossings	7-7	7-6
8. TERMINALS		
Introduction	8-1	8-1
Siting and General Layout	8-2	8-1
Track Design	8-3	8-1
Clearances and Usable Track Length	8-4	8-2
Vehicle Terminals	8-5	8-2
Break Bulk (Small Cargo) Terminals	8-6	8-7
Container Terminals	8-7	8-7
Ammunition Terminals	8-8	8-9
POL Terminals	8-9	8-9
Car Interchange	8-10	8-9
Yard, Storage, and Other Auxiliary Tracks	8-11	8-11
Miscellaneous Buildings	8-12	8-13
Security Fencing	8-13	8-13
9. CONSTRUCTION		
Construction Survey	9-1	9-1
Inspecting Materials	9-2	9-1
Saving Salvageable Materials	9-3	9-1
Subgrade and Drainage	9-4	9-1
Track Construction	9-5	9-1
Quality Control/Quality Assurance	9-6	9-3
As-Built and Final Drawings	9-7	9-3
APPENDIX		
A. REFERENCES		A-1
B. RULING GRADE-EXAMPLE PROBLEM		B-1
C. TRACK (1.0): TRACK DESIGN AND EVALUATION FOR WORK PLANNING AND BUDGETING-DESCRIPTION AND EXAMPLE		C-1
D. EXAMPLE TRACK REHABILITATION REPORT		D-1

List of Figures

	Page
2-1. Common Freight Cars	2-3
3-1. Combining Curves	3-2
6-1. Example load distribution along the track	6-2
6-2. Example vertical pressure reduction through the track	6-3
6-3. Relationship between maximum track deflection and long term track performance	6-4
6-4. Design wheel configurations	6-5
6-5. Typical cross section-tangent track	6-7
6-6. Typical cross section with subballast layer-tangent track	6-7
6-7. Typical cross section-curved track	6-8
6-8. Typical cross section with subballast layer-curved track	6-8
6-9. Typical cross section-track with adjacent service road	6-9
6-10. Typical cross section-track with geotextile	6-9
6-11. Typical cross section with subballast layer-track with geotextile	6-10
6-12. General method for determining the frost susceptibility of soils	6-11
6-13. Design air freezing indexes in North America	6-12
6-14. Air freezing index/Surface cover/Frost penetration relationship	6-13
6-15. Required subdrainage where surrounding natural ground is above bottom of ballast and open side ditches cannot be installed	6-15
6-16. Geotextile installation under a turnout	6-16
6-17. Geotextile installation at a bridge abutment	6-16
6-18. Anti-Splitting Devices for Tie Ends	6-18

	Page
6-19. Tie Plates	6-22
6-20. Recommended Minimum Rail Anchor Application	6-23
6-21. Rail Anchors	6-24
6-22. Rail Anchor Applications at Open Deck Bridges and Rail Crossings	6-25
6-23. General Arrangement of Turnouts and Crossovers	6-26
6-24. Parts of a Turnout	6-27
6-25. Typical Type 1A Gravel Crossing	6-30
6-26. Typical Type 1B Gravel Crossing	6-31
6-27. Typical Type 2 Timber Crossing	6-32
6-28. Typical Type 3 Asphalt Crossing	6-33
6-29. Typical Type 4A Cast-in-Place Concrete Crossing	6-34
6-30. Typical Type 4B Prefabricated Concrete Crossing	6-35
6-31. Typical Type 5 Elastomeric (Rubber) Crossings	6-36
6-32. Typical Geotextile/Subdrain Installation for Road Crossings	6-37
6-33. Typical Drainage at Road Crossings	6-38
6-34. Recommended Track Construction for Road Crossings	6-39
6-35. Clear Crossing Visibility Area for Approaching Vehicles	6-40
6-36. Clear Crossing Visibility Area for Stopped Vehicles	6-41
6-37. Cooper Loading Configuration for Bridges	6-43
6-38. Variation in Cooper E Value with Span Length	6-44
6-39. Loading Diagram for Train of 100-Ton Boxcars	6-45
6-40. Location of Derails	6-47
7-1. Determining Frog Number (Turnout Size)	7-3
7-2. Turnout Design	7-4
7-3. Diverging Route Connection	7-5
7-4. Parallel Siding Connection	7-6
7-5. Ladder Track Layout	7-7
7-6. Clearance Diagram for Tangent Track	7-8
7-7. Location of Clearance Points	7-10
8-1. Typical Small Yard with Storm Drainage	8-2
8-2. Vehicle Terminal	8-4
8-3. Track and Approach Road Lengths for Vehicle Loading	8-5
8-4. Concrete End Ramp	8-6
8-5. Portable Multilevel Ramp	8-7
8-6. Concrete Side Ramp	8-8
8-7. Interchange Yard	8-10
8-8. Auxiliary Tracks	8-12
C-1. Main Menu for TRACK(1.0)	C-2
C-2. Tie Decay Hazard Map of the U.S.	C-3
C-3. Report from TRACK(1.0)	C-3
D-1. Track Diagram for Fort Example	D-6

List of Tables

	Page
2-1. Common Cargo Types and Loading Requirements	2-2
2-2. Common Car Types and Design Wheel Loads	2-4
3-1. Grade Design Categories for Main Running Tracks	3-1
3-2. Recommended Minimum Grade Lengths	3-1
3-3. Curve Design Categories for Main Running Tracks	3-2
3-4. Curve Compensation for a 1% Grade	3-2
3-5. Estimating Locomotive Tactive Effort	3-3
3-6. Design Gross Car Weights	3-3
6-1. Suggested Design Track Modulus Values	6-5
6-2. Rail Sections	6-5
6-3. Recommended Ballast Gradations	6-17
6-4. Dimension and Surface Specifications for Relay (Secondhand) Rail	6-20
6-5. Switch Ties for Standard Turnouts	6-28
6-6. Recommended Crossing Surfaces	6-29
6-7. Clear Visibility Distances at Road Crossings	6-42
6-8. Recommended Cooper Design Load for Bridges	6-46
7-1. Recommended Transition Rates Between Grades on Main Running Tracks	7-1
7-2. Design Superelevation for Curved Track	7-2
7-3. Turnout Size Selection Criteria	7-3
7-4. Overhead and Side Clearances for Tangent Track	7-9

	<i>Page</i>
9-1. Suggested Stake Intervals for Final Survey	9-1
9-2. Rail Joint Gap	9-2
B-1. Curve Compensation for 1.16% Grade	B-1
C-1. Add 6" Ballast to Track	C-5
C-2. Add 6" Ballast and Install 115 lb Rail	C-5
C-3. Add 6" Ballast and Install 7" x 9" Ties	C-5
D-1. Key to Track Names and Station Locations	D-7
D-2. Cost Estimate Summary	D-10
D-3. Road Crossing Repair/Rebuilding	D-11
D-4. Turnout Rehabilitation	D-13
D-5. Ballast and Surfacing Locations	D-14